

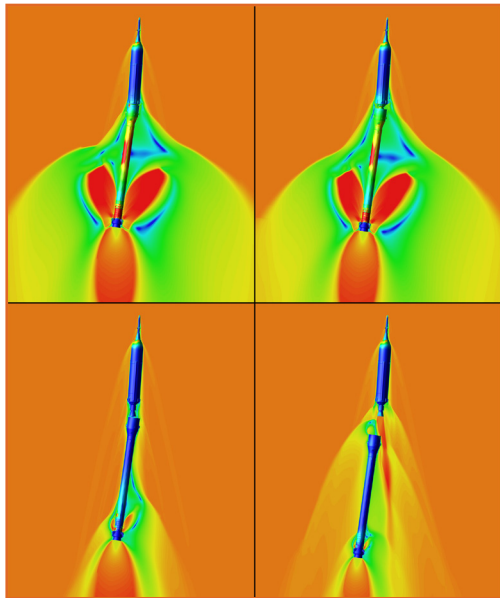
Space Exploration

Aerodynamics of the Ares I Crew Launch Vehicle During Stage Separation

Exploration Systems Mission Directorate

A team of modeling and simulation experts at the NASA Advanced Supercomputing facility has performed high-fidelity computational fluid dynamics (CFD) simulations of stage separation for the Ares I Crew Launch Vehicle. These simulations model the complex aerodynamic forces and interactions that play a crucial role during separation of the vehicle's first stage solid rocket booster from its upper stage engine during ascent.

These high-fidelity analyses are performed using the viscous CFD code OVERFLOW with high-resolution computational grids including complex geometrical details of the vehicle. The team modeled a wide range of separation conditions covering different Mach numbers, flight angles, separation distances, and angles between the two stages. Extensive powered stage separation simulations also modeled plume effects from the vehicle's various stage separation motors and assessed numerous off-nominal scenarios with some motors not functioning.



The intensive analyses needed to capture the complex flow physics involved in stage separation are computationally demanding, requiring upwards of 1,000 processors and one to two weeks of run-time on NASA's Pleiades supercomputer for each case, and generating several hundred terabytes of data overall. This critical aerodynamic data is used to help design the Ares I launch vehicle and develop a safe, effective stage separation system.

*Henry C. Lee, NASA Ames Research Center
henry.c.lee@nasa.gov*

Visualization of stage separation flow physics, starting from the firing of the booster deceleration motors and ullage settling motors (upper left), and ending with the start-up of the J-2X motor on the upper stage (lower right). *Jeff Onufer, Henry Lee, NASA/Ames*